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(54) Structural members.

(57) An elongate structural member (100) comprises an elongate body part made of sheet metal which has been cold formed into the cross-sectional shape required and provided with an attachment portion (120) at each end.

FIG 1A

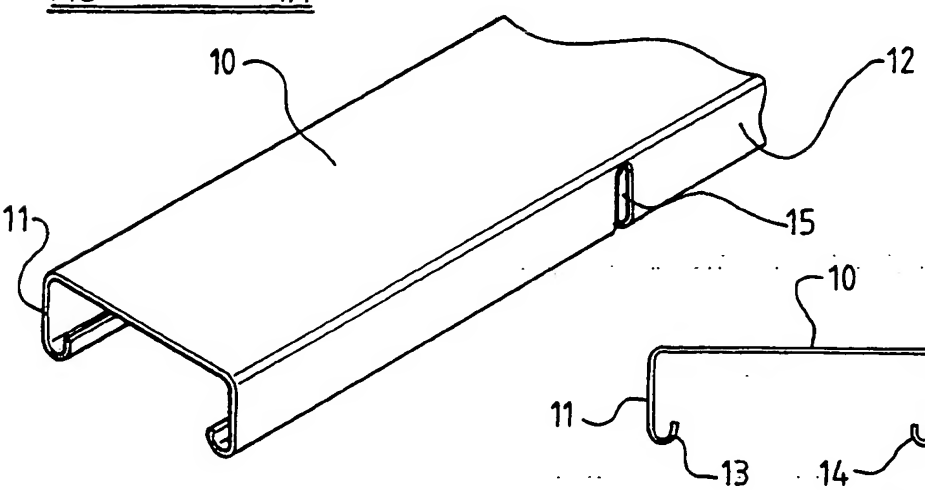

FIG 1B

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This invention relates to an elongate structural member provided with an attachment portion at each end for attachment to other elements. Such members are widely used in buildings and the like as bracing elements, e.g. as structural ties for roof structures, trusses, stanchions and space frames. Such a structural member will hereinafter be referred to as a structural member of the kind specified.

A structural member of the kind specified has hitherto comprised a hot rolled tube provided with an attachment portion at each end. Such members made of hot rolled tube have generally been relatively expensive and heavy. They are made by cutting to length from a stock length of tube of a diameter and wall thickness which approximates as far as possible to that required for the structural strength. However, because the tube is bought in standard sizes, the tube cross-sectional dimensions cannot be tailored to each particular application. In addition, the need to cut to length from a standard length generally leads to a significant amount of waste.

In addition, the steps of welding on a cap plate to each end of the tube and a T-piece to provide the attachment portions is required followed by shot blasting and painting.

An object of the present invention is to provide a structural member of the kind specified whereby the abovementioned disadvantages are overcome or reduced.

According to a first aspect of the present invention we provide an elongate structural member comprising an elongate body part made of sheet metal which has been cold formed into the cross-sectional shape required and provided with an attachment portion at each end.

The body part may comprise wall portions having edge portions extending lengthwise of the member and lying adjacent to one another, said edge portions being secured to one another by fastening means provided at least at spaced intervals along the members.

Preferably the body part is of a closed hollow or tubular configuration, e.g. of generally square, rectangular, circular, or other, cross-sectional shape.

The body part may comprise a unitary member having a pair of side-by-side edge portions which are secured together by said fastening means.

The side-by-side edge portions may be secured together by fastening means selected from welding, such as spot welding or other local welding; fasteners, such as screw thread fasteners, rivets, clips; crimping; clinching; or adhesive.

The edge portions may comprise two flanges secured together in side-by-side relation.

The flanges may extend outwardly relative to the interior of the closed cross-section.

Where the cross-section of the body part is rectangular, the flanges may be disposed between the ends of one side wall and preferably adjacent the middle thereof and extend outwardly thereof perpendicular to the plane of said wall.

Alternatively, the body part may be a compound member, i.e. one comprising two or more components secured together, each component affording part of the overall cross-section of the body part.

The wall portions may be wall portions of the two components.

Both where the member is a unitary member or a compound member, said fastening means may comprise means mechanically interfitting with at least one edge portion.

Such fastening means may comprise a weld or clip means interfitting with both edge portions, or a formation or formations on one edge portion interfitting with the other edge portion.

The edge portions may be provided with inturned lips so that they are each generally of U-shape in cross-section, with the bases of the two U-section portions lying adjacent one another and the limbs of the U-section portions extending away from one another. Then a, generally C-shaped, clip may engage the two edge portions.

Instead of a C-shaped clip engaging both edge portions where each edge portion has an inturned lip so as to be generally of U-section as above described, a part of its inturned lip or a wall portion adjacent such inturned lip, may be displaced to engage the inturned lip of the edge portion. Thus the requirement for separate clips may be avoided.

Whether separate clips or parts of one edge portion are used to secure the edge portions together, the security of such fastening means may be enhanced by a pressing or like operation or operations to deform the interfitting parts into a close-fitting relationship. To facilitate the carrying out of such operation or operations, one or more openings may be provided for access of a tool to the interior of the structural member. For example, if a number of fastening means are provided at spaced intervals along the length of the member, an opening may be provided adjacent each fastening means.

Although such structural members comprising at least one cold formed metal section can support substantial loads, a difficulty is encountered in providing a connection to such a structural member in such a way that loads can be effectively transferred between the member and the thing to which it is connected. Because of the relatively thin gauge of the sheet material of which the member is formed, the use of mechanical fas-

tenings such as bolts connected directly to the member severely limits the loads which can be transferred. For larger loads, an uneconomic and impractical number of such fasteners would have to be used. Welding is undesirable because the heat affects the properties of the material and may reduce the yield stress thereof. A further reason for wishing to avoid welding is because thin gauge cold formed steel sections very often are galvanised to protect against corrosion, and welding on galvanised sections not only damages the galvanised surface but also is a health hazard.

It is a further object of the present invention to provide a structural member whereby the above described disadvantages are overcome or reduced.

According to a first more specific aspect of the invention, we provide a structural member according to the first aspect of the invention wherein at least one attachment portion comprises portions of the member displaced out of their original cross-sectional positions into positions adjacent to one another and adapted to cooperate with fastening means.

By their original cross-sectional positions, we mean the positions where such portions lie in the normal cross-section of the member other than at its attachment portion.

Preferably said portions lie in face-to-face relationship with one another so as to provide at least two thicknesses of the material of which the member is made.

By displacing portions of the member out of their original cross-sectional position into positions adjacent to one another, sufficient thickness of material can be provided for fastening means such as bolts to cooperate directly with said portions. Thus a structural member according to the invention and provides for satisfactory transfer of forces between the attachment portion and the rest of the member.

The member is preferably of closed hollow cross-sectional shape, and said portions displaced in said attachment portion from their original cross-sectional positions are portions which lie generally opposite one another in the normal cross-section of the member. Thus, where the cross-sectional shape of the member is rectangular or generally rectangular, the portions deformed into positions adjacent one another are preferably opposed wall portions of the rectangular cross-section.

Preferably said portions lying adjacent one another are connected to the undeformed part of the member by portions inclined to the length of the member.

Where the body part is a compound member comprising two or more components secured together, to provide the attachment portion at an end of the structural member, portions of each of said components preferably are displaced out of their original cross-sectional positions, into positions wherein they will lie adjacent to one another, in the member, prior to connection of the components to one another to form the member.

In the examples of members and methods of manufacture thereof according to the invention described in detail hereafter, the member may be of hollow, generally rectangular, cross-sectional shape and comprise two channel section components connected to one another. Each channel section component comprises, as viewed in cross-section, a generally flat base and two generally flat walls extending from the base substantially parallel to one another, the components being secured to one another along the free edge portions of such walls. The free edge portions of the walls may be provided with inturned lips, and the components may be held together by fastening means such as clips extending lengthwise of the member or provided at spaced intervals along the length of the member, said fastening means engaging said inturned lips. Alternatively the free edges of the walls may have cross-sectional shapes which interfit with one another and which may be pressed, crimped, or otherwise deformed to hold them in engagement with one another. Yet further alternatively the components may be welded to one another continuously or at spaced intervals along abutting free edges of the walls.

Openings may be provided at spaced intervals along the length of the member to enable access to be gained to the interior thereof for the purpose of introducing and engaging clips or to enable a tool to be entered into the interior of the member for use in a crimping or pressing operation.

Said portions displaced out of their original cross-sectional positions may comprise portions of the base of each of the channel section components and may also include portions of the walls thereof.

Parts of the walls of each channel section component may be deformed, at the end of the component, to lie in face-to-face relationship with the base thereof. If the cross-sectional shape of the structural member is rectangular, and the height of each of the walls is thus substantially half the transverse dimension of the base of each channel section component, the parts of the walls when deformed into face-to-face relationship with the base may substantially meet one another along their free edges and afford a portion having a double thickness of material. An end portion of the portions thus formed may be pressed so that the walls lie flattened and close to the base, and the resulting component may then further be deformed so that such flattened portion lies substantially in line with the free edges of the walls of the undeformed component, connected to the base of the undeformed component by an inclined portion. Then, when the two channel section components thus deformed are secured together there is provided an attachment portion which, being constituted by the base

and walls of each of the constituent channel section components of the structural member, comprises four thicknesses of the material of the member.

Alternatively, for each channel section component of the structural member parts of the walls at the end thereof may be removed completely, and the base of each component folded back upon itself about a transverse fold line to provide a double thickness of material. The walls may be cut with inclined edges to extend from such double thickness portion and the component deformed as above described so that the double thickness portion of the base lies substantially in line with the free edges of the walls of the undeformed component. In such deformation of the component, the walls thereof may be provided with inwardly folded portions.

When the two channel section components thus configured are secured together there is provided an attachment portion which, comprising a double thickness of the base of each of the constituent channel section components, comprises four thicknesses of the material of the member.

The attachment portion may be provided with an aperture or apertures for receiving fasteners such as bolts, and if required a reinforcement member or members may be provided in the region of such aperture or apertures.

According to a second more specific aspect of the invention we provide a structural member according to the first aspect of the invention wherein at least one attachment portion comprises an attachment component formed separately from said body part and fastened thereto.

The attachment component may be fastened to said body part by fasteners or by welding.

The attachment component may have a portion disposed within the body part and connected thereto.

The attachment component may be of channel shape, the limbs of the channel being disposed in side-by-side relationship with two opposed walls of the body part.

Each side-by-side limb and wall may be connected together by fasteners such as by screw-threaded fasteners or rivets or crimping or may be fastened together by welding.

Reinforcing means may be provided to reinforce the connection, for example, by being disposed on the outside of the wall parts when the attachment component is disposed on the inside and between an abutment part of the fastening means and the attachment component.

The attachment component, for example the base of the channel, may be provided with means to connect the attachment component to another member.

Said means to connect the attachment part to another member may comprise at least one aperture to receive a fastener.

Closure means may be provided to close an opening in the transverse cross-section of the cold rolled member.

The closure means may comprise a member extending between the internal wall of the cold rolled member and, when provided, the external surface of the attachment component.

According to a second aspect of the invention we provide a method of providing an elongate structural member comprising an elongate body part having an attachment portion at each end, comprising the step of cold forming sheet metal into the cross-sectional shape required for the body part.

The method may further comprise securing wall portions of the body part to one another along edge portions of the wall portions extending lengthwise of the member and lying adjacent to one another, by fastening means at least at spaced intervals along the member.

According to a third more specific aspect of the invention, we provide a method of providing a structural member according to the second aspect of the invention comprising displacing portions of the member out of their original cross-sectional positions into positions adjacent to one another and providing means for cooperation of said portions with fastening means.

According to a fourth more specific aspect of the invention we provide a method of providing a structural member according to the second aspect of the invention comprises fastening an attachment component, formed separately from said body part, to said body part.

According to a third aspect of the invention we provide a building structure comprising two spaced apart elements having a structural member according to the first aspect of the invention, or made according to the second aspect of the invention extending therebetween and connected thereto in bracing relationship.

The invention will now be described by way of example with reference to the accompanying drawings, of which:-

Figure 1A and 1B are respectively a perspective view and transverse cross-sectional view of a channel section component to be used in manufacture of a structural member according to the invention;

Figures 2A and 2B, and 3A and 3B, are views as Figure 1 of the channel section component, showing two further operations thereon in manufacture of a structural member according to the invention;

Figure 4 is a side view of the component shown in Figures 3A and 3B;

Figure 5 shows a further operation in production of the member;

Figures 6 and 7 show further stages in the production of the member;
Figures 8A and 8B are views as figures 1A and 1B but showing the production of a further embodiment of member according to the invention;
Figures 9A and 9B show the next stage in the production of the embodiment of Figure 8;
Figures 10, 11 and 12 show further stages in the production of the further embodiment of member;
Figure 13 shows the further embodiment in its final configuration;
Figure 14 is a perspective view of a modified embodiment of the invention;
Figures 15 and 16 show a further modification of the structural member;
Figures 17 and 18 are cross-sectional views showing further structural members to which the invention may be applied;
Figure 19 is a detail of the cross-section of an embodiment of structural member according to the invention;
Figures 20A and 20B are cross-sectional views of part of a further embodiment of structural member according to the invention;
Figure 21 to 23 illustrate, in cross-sectional and lateral views, part of yet a further embodiment of structural member according to the invention;
Figure 24 is a lateral view of part of yet a further structural member according to the invention;
Figures 25A and 25B are cross-sectional views of alternative arrangements of part of the member of Figure 24;
Figure 26 is a fragmentary perspective view of another embodiment of a structural member embodying the invention;
Figure 27 is a side elevation of the member of Figure 26;
Figure 28 is an end view of the member of Figure 26;
Figure 29 is a perspective fragmentary view showing the connection between a structural member embodying the invention and another element;
Figure 30 is a diagrammatic elevation of a building embodying the invention showing a portal frame thereof;
Figure 31 is a fragmentary illustration showing a means for connecting flanges of the member of Figure 26; and
Figure 32 is a graphical representation showing the relationship between load bearing capacity and span of structural members embodying the invention.

Referring firstly to Figures 1A and 1B, there is shown a component which is a channel section component having a base 10 which is flat and walls 11, 12 extending from the base, parallel to one another. The walls 11, 12 are provided at their free edges with inturned lips 13, 14 respectively. The intention is that two such components should be assembled with their bases parallel and spaced from one another and the edges of their walls 11, 12 abutting to provide a structural member of rectangular hollow, i.e. tubular configuration, the two channel section components being secured together in such position by means to be described hereafter.

As a first step in the manufacture of the structural member, a coil of sheet metal is decoiled to provide a blank and then, in a pressing operation a desired length of the decoiled sheet metal is severed from the remainder of the coil and cuts or slots are formed, which in the finished member will extend from the free edge of the walls 11, 12 to the base. Such a cut or slot is indicated at 15 in Figure 1A, a predetermined distance, e.g. 300mm, from the free end of the component. The thus form slotted blank is cold rolled, or otherwise cold formed to provide the channel shape shown in Figure 1A.

Alternatively, if desired, the sheet metal may be decoiled and cold rolled or otherwise cold formed to the desired channel shape shown in Figure 1A on a continuous basis and then cut to length after forming with suitably shaped cutting tools. Thereafter or at the same time, cuts or slots 15 are provided.

The next step is, as indicated in Figure 2B, that the walls 11, 12, from the free end of the component to the slots as 15 in the walls, are folded to lie in face-to-face proximity to the base 10. Because of the lips 13, 14 on the face edges of the walls, the walls remain slightly spaced from the base.

The next step is shown in Figure 3A, wherein approximately half the length of the inwardly folded walls and base of the component is subjected to a pressing operation to flatten the lips 13. As shown in Figure 3B, the walls then lie in close face-to-face relationship with the base 10. A side view of the resulting component is shown in Figure 4, wherein the end portion which has been pressed flat is indicated at 16, extending approximately half way from the free end of the component to the part thereof which has not been deformed at all. The relatively greater thickness of the portion, indicated at 17, wherein the walls of the channel section component have been folded in towards one another but not pressed flat, compared with the pressed portion 16, can be clearly seen.

The next step performed on the component thus provided is indicated at Figure 5. The portions 16, 17 are together bent so that they remain in line with one another but are inclined to the base 10. The boundary between the portions 16, 17 is in line with the edge of the walls 11, 12 of the channel section component.

The next step in manufacture of the member is shown in Figure 6. The portion 16 is bent relative to the portion 17 so as to be parallel to and in line with the edges of the walls 11, 12 of the channel section component. Holes as indicated at 18 may be drilled in the portion 16 at this stage.

Figure 7 shows a structural member comprising two components formed as shown in Figure 6 and placed with the edges of their walls as 11, 12 in abutment with one another. The portions 16 lie in close face-to-face relationship with one another. The components may be secured together by tack welding along the line indicated at 19 where the free edges of the walls abut one another, or possibly by the use of clips as described hereafter. The holes as 18 provided in the portions as 16 enable fasteners such as bolts to be passed therethrough to secure the structural member to another member or component where it is to be used. The portions 17 provide effectively for transmission of forces between the portions 16 and the hollow body portion of the structural member.

The cross-sectional shape of the hollow body part of the structural member is shown in Figure 7A, with the lips at the edges of the walls as 11, 12 abutting one another and welded thereat.

Referring now to Figures 8A and 8B of the drawings, these figures illustrate a first step in an alternative method of manufacturing a structural member according to the invention from two channel-section components. A channel section component having a base 20 and walls 21, 22 extending therefrom is illustrated, the walls having inturned lips 23, 24 along their free edges. The component is made by cold rolling or other cold forming operation in either the sequences described in connection with the first embodiment. At an end portion of the component the walls 21, 22 are completely cut away from the base 20 for a length of, for example, 300mm and then for a length of, for example, 150mm the walls 21, 22 are cut at an inclination until the uncut edges of the walls are reached. The extreme end portion of the base 20, e.g. for a length of 150mm, is folded back on itself about a fold line 25 extending transversely of the base 20. The result of carrying out this folding step is shown in Figures 9A and 9B in perspective view and transverse cross-section, and in side view in Figure 10. It will be noted that at this stage the channel section component has the portion, indicated at 26, at its free end where the base has been folded back on itself about the transverse fold line 25 and wherein there is a double thickness of the material of the component, followed by a portion indicated at 27 wherein the side walls have been cut to provide an inclined edge extending from the base to the free edges of the uncut side walls having the inturned lips 23, 24.

The next operation performed on the component is to fold the portions 26, 27 together about a transverse line or region 28 on the base of the component, so that the inclined edge, 29, of each wall 21, 22 remaining in the portion 27 is parallel to the free edge of the uncut walls 21, 22. Adjacent the fold line 28, the material of the side walls is inwardly folded as indicated at 30 to enable this to be done. The resulting component is shown in Figure 11.

The next operation formed on the component is to reverse bend the portion 26 thereof so that it is generally in line with the free edges of the walls of the channel section component. The portion 26 may then be drilled to provide apertures 31, as shown in Figure 12.

Two components as shown in Figure 12 are then placed together such that the edges of their walls are in contact with one another and their portions 26 lie in face-to-face relationship with one another. The abutting free edges of the walls of the components may be tack welded at intervals along the length of the components to provide a structural member whose body part cross-sectional shape is a closed rectangle. Fasteners such as bolts may be passed through the apertures as 31 in the facing portions 26 of the two components to secure the structural member to another component in a building structure or the like.

Figure 14 shows a perspective view of the end region of the structural member 13, with an additional optional feature. In Figure 14, the base 20 of each of the channel section components of the structural member is stiffened by two pressed-in grooves 33 which extend lengthwise of the component in the portion 27 thereof and a short distance into the part of the base where the channel section component is not otherwise altered. Stiffening formations of other configurations could be provided, extending longitudinally or transversely of the structural member, and possibly such formations could extend throughout the entire length of the structural member.

Figures 15 and 16 are perspective views showing a further possible modification of the attachment portion of the structural member. Instead of providing two apertures in the portion 26 of each of the channel section components forming the structural member, necessitating the use of two fasteners such as bolts to secure the structural member in use, an aperture for a single fastener is provided as indicated at 34, flanked by openings 35 for receiving tongues 36 on a reinforcement member 37. Figure 16 shows a fastening bolt 38 passed through the reinforcement member.

The invention is applicable to structural members whose cross-sectional shape is other than the rectangular shape above described, and to structural members other than those comprising two constituent components secured together. Figure 17 shows in transverse cross-section a structural member comprising two

components 40, 41 of substantially semi-circular cross-section, abutting one another along their edges which have inturned lips as 42. The components may be welded or otherwise secured, e.g. by clips, along such edges. At an end of the structural member to provide an attachment portion, opposed portions of the components may be deformed towards one another in manner analogous to that described above.

Figure 18 shows a substantially square cross-section member, which comprises a single component only. In a succession of cold rolling or other cold forming operations, the component is provided with a base 50, side walls 51, 52, and top walls 53, 54 which terminate in inturned lips 55, 56 which abut one another. Welding or clips may be used at spaced intervals along the line of such abutment to secure the walls 53, 54 together to provide the structural member.

As above referred to, fastening means such as clips may be used instead of welding to secure two components together to form a structural member, or to secure adjacent edges of a single component together to form a structural member. A possible configuration of one such clip is shown in Figure 19. In this figure, wall portions 60, 61 are shown with inturned lips 62, 63 at their edge portions, which are generally of U-shape in cross-section and of which the bases abut one another. A clip 64 of resilient material comprises a base 65 which extends across the two lips 62, 63, and portions 66, 67 which engage behind the lips 62, 63 to hold the walls 60, 61 together.

If such clips are used in a structural member, provided at spaced intervals along the length of the member, apertures may be provided in the member to enable access to be gained to the interior thereof for the purpose of fitting such clips.

Referring now to Figures 20A and 20B, these show a further possible arrangement of clip for securing adjacent edge portions of a single component, or of two components, together to form a structural member. Wall portions 70, 71 of the component or components are illustrated, with inturned lips at their free edge portions such that the edge portions are generally of U-shape in cross-section, with base portions 72, 73 of the U-shapes lying adjacent one another and limbs 74, 75 thereof extending away from one another. A generally C-shaped clip member 76 made of a malleable metallic material engages the limbs 74, 75, and subsequent to such engagement is subjected to a crimping or pressing operation so that it is deformed to the configuration shown in Figure 20B. When thus deformed, the clip member closely embraces the limbs 74, 75 and a portion of the clip member, indicated at 77, extends partially into the region where the limbs 74, 75 diverge from the portions 72, 73. Thus a secure mechanical connection is provided between the adjacent edge portions of the walls 70, 71 of the component or components.

To enable access to be gained to the clip member 76 for carrying out such deformation thereof, an opening or aperture may be provided in the structural member adjacent the member 76. If fastening members such as 76 are provided at spaced intervals along the structural member, a respective aperture may be provided adjacent each member, to permit a pressing tool to be introduced to the interior of the member.

Instead of clips such as 64 or 76 being provided at spaced intervals along a structural member, elongate fastening members of similar or analogous cross-sectional shape to such clips could be provided, extending along all or most of the length of the structural member.

Instead of separate fastening means, such as clips as above described, being used for securing adjacent edge portions of one or more components to one another, a fastening formation or formations may be provided at one edge portion and arranged to engage the other edge portion. One possible such fastening formation is illustrated in Figures 21 to 23. Figure 21 shows wall portions 80, 81 with respective edge portions 82, 83 which are inturned lips so that the edge portions are of U-shape, as previously shown in Figure 20. Adjacent its edge portion, one of the wall portions 80 or 81, in this case the wall portion 80, is provided with a pressed-out tongue portion 84 which extends generally perpendicular to the edge portion, remaining integrally secured to the wall portion at its end 85 nearest the edge portion.

To secure the two edge portions together, the tongue 84 is bent downwardly as shown in Figure 23A to a generally C-shaped configuration to engage beneath the inturned lip constituting the other edge portion 83. Finally a pressing operation further deforms the tongue 84 and the two edge portions 82, 83, to the configuration shown in Figure 23B to provide a secure connection. Such deformation of the tongue 84 requires the introduction of a tool into the interior of the structural member, either through the aperture left by the pressing-out of the tongue 84 or through another aperture provided in the vicinity thereof.

An edge portion of a wall may itself be arranged to provide a formation engagable with another edge portion to secure two components or parts of a component together. Figure 24 shows a lateral view of part of a structural member comprising two wall portions 90, 91 of a component or components, with edge portions 92, 93 respectively lying adjacent one another, the two edge portions being of U-shaped configuration as above described. To provide a fastening formation, at two points 94, 95 spaced from one another lengthwise of the member the inturned lip of one edge portion may be sheared through, whilst the inturned lip of the other edge portion is partially cut and removed. Then, as shown in Figure 25A or 25B, the lip 96 on the component 90 between

the points 94, 95 is deformed from its original position (shown shaded) to engage the remaining edge portion 97 of the component 91. Such an arrangement may be provided at a number of positions spaced along the length of the structural member.

Referring now to Figures 26 to 28, a substantially square cross-section body part is indicated generally at 100 and is again made from a coil of sheet material by cold rolling or other cold forming operation in either of the sequences described in connection with the first embodiment to the configuration shown in Figure 1 so as to have a base 101, side walls 102, 103, top walls 104, 105 having along edge portions thereof out-turned lips or flanges 106, 107 which extend perpendicular to the top walls 104, 105.

The flanges 106, 107 are secured to one another by fastening means which, in the present example comprises tack or spot welding but may be any other suitable fastening means such as other local welding or continuous welding or fasteners such as screw-threaded fasteners, rivets, clips, by crimping, clinching or by adhesive or by any other desired manner.

One preferred alternative to tack welding is to act upon one of the flanges with a punch substantially perpendicular to the surface of the flange and the other flange having a die on the opposite side thereof of a re-entrant configuration so that the punch forces metal of the two flanges into the die to form a rivet type or crimped, clinched fastening, the die has movable parts to enable removal thereof from the thus formed fastening. Such an arrangement is shown in cross-section in Figure 31 and is known as "Tog-L-Loc".

Such fastening operation is performed at a plurality of positions along the length of the flanges 106, 107.

Alternatively, any of the previously described fastening means such as clips etc. as used in connection with any of the previous embodiments may be provided.

The body part member 100 is provided with an attachment component 120 which, in the present example is of channel configuration comprising a base 121 and spaced parallel upstanding beams 122, 123 which are perpendicular to the base 121. The channel shaped attachment member 120 is made in any convenient manner but again is preferably made by a cold forming operation such as cold rolling from a blank cut from a coil of strip material as described hereinbefore, or if desired, the strip may be cold formed to channel shape and then cut to length.

A pair of apertures 124 are provided in the base of the channel in any convenient manner, preferably during the cutting to length operation and, in addition, apertures, not shown, are formed in the limbs 122, 123 to receive bolts 125 which extend through apertures, not shown in the side walls 102, 103 of the cold formed member 100. Again these apertures in the walls 102, 103 are preferably formed during the cutting to length operation prior to cold forming.

The bolts 125 have a generally rectangular reinforcing plate 126 disposed beneath their heads 127 so that the relatively thin material of the side walls 102, 103 is clamped by the bolts between the plate 126 and the associated wall 122, 123.

By virtue of having a separate attachment component 120, the attachment component may be made of material of appropriate composition and thickness so as to render it capable of accommodating the stresses imposed in use when it is connected to components to be braced. In addition by providing the reinforcing plates 126, the connection of the attachment component to the cold rolled box section member 100 is also rendered capable of accommodating the necessary stresses. At the same time the material of which the box section member is made can be relatively thin whilst still providing adequate strength.

In general the box section may be provided with adequate strength by making the box section member of relatively thin gauge material compared with that necessary for the attachment portion and therefore considerable saving in cost of materials and weight can be achieved by making the attachment portion as a separate component of relatively greater thickness than the material of the main part 100 of the structural element.

For example a member embodying the invention may be of the following dimensions where a, b and c are the dimensions illustrated in Figure 28.

Section	Wall Thickness (mm)	Dimensions (mm)		
		a	b	c
1	1.5	82	18	50
2	1.5	100	50	75
3	2.0	100	50	75
4	2.4	100	50	75
5	3.2	100	50	75

Figure 32 is graphical representation showing the ultimate compression capacity in kilo Newtons plotted against span in metres of members embodying the invention and having the dimensions indicated above.

It will be seen that, for example, in the case of Section 1, the strength of the member up to a span of 4 metres is limited by the strength of the attachment portion whereas in the case of Section 2, the strength is limited by the strength of the attachment portion up to a span of about 6.75 metres since the box section member of Section 2 is stronger than that of Section 1 by virtue of its greater dimensions, a, b and c.

As can be seen from Figure 32, Sections 3, 4 and 5 are of the same dimensions a, b and c as Section 2, but are of greater wall thickness and hence of greater strength than that of Sections 1 and 2.

In the present example, the channel shape attachment portions for Sections 1 to 5 are of two sizes. The attachment portion for Section 1 has a wall thickness of 6mm and the limbs of the channel (dimension 'd' in Figure 28) are 64mm. The attachment portions for each of Sections 2, 3, 4 and 5 have a wall thickness of 8mm and a dimension 'd' of 100mm.

Referring now to Figure 29 a member as described with reference to Figures 26 to 28 is indicated generally at 100 and is shown attached to a lug 130 welded, as shown at 131 to a web 132 of an I-section rafter 133. Bolts, not shown are provided to bolt the base of the attachment component 120 to the lug 130 through the apertures 124 of the component 120 and corresponding apertures 134 of the lug 130.

Figure 30 illustrates a typical portal frame 140 of a steel frame building provided with a plurality of lugs 130 to each of which pairs of members embodying the invention are bolted as described hereinbefore so as to brace, in a zig-zag manner, the portal frame 140 relative to an adjacent frame disposed within the building. If desired, the bracing may also be provided between stanchions of the portal frame and corresponding stanchions of the next adjacent frame.

The structural members embodying the invention overcome the disadvantages discussed hereinbefore in connection with previously made hot rolled members in that they are made from material cut to length without waste and avoid the need for extensive welding operations followed by shot blasting and painting since the sections made be made from galvanised steel. In addition, the sections are of lighter weight. For example, in the case of the embodiment described with reference to Figures 26 to 32 when used in a 30 metre span portal building 6.5m to the eaves and with a 6° roof slope with gable posts spaced at 6m intervals and assuming a wind loading of 45m per second and a ground reference of 2b, a total of twelve brace members embodying the invention are required having a total weight of about 560kg compared with a total weight of about 1060kg for conventional hot rolled circular hollow section bracing members.

If desired, in all embodiments a closure member such as a foam plastics/rubber pad may be provided at and to close the open end of the tubular body to prevent the ingress of insects or detritus.

The features disclosed in the foregoing description, or the following claims, or in the accompanying drawings, expressed in their specific forms or in terms of a means for performing the disclosed function, or a method or process for attaining the disclosed result, as appropriate, may, separately or in any combination of such features, be utilised for realising the invention in diverse forms thereof.

Claims

1. An elongate structural member comprising an elongate body part made of sheet metal which has been cold formed into the cross-sectional shape required and provided with an attachment portion at each end.

2. A member according to Claim 1 wherein the body part comprises wall portions having edge portions extending lengthwise of the member and lying adjacent to one another, said edge portions being secured

to one another by fastening means provided at least at spaced intervals along the members.

3. A member according to Claim 2 wherein the body part is of a closed hollow or tubular configuration.

4. A member according to Claim 3 wherein the body part comprises a unitary member having a pair of side-by-side edge portions which are secured together by said fastening means.

5. A member according to Claim 4 wherein the edge portions comprise two flanges secured together in side-by-side relation.

6. A member according to Claim 5 wherein the flanges extend outwardly relative to the interior of the closed cross-section.

7. A member according to Claim 3 wherein the body part is a compound member, comprising two or more components secured together, each component affording part of the overall cross-section of the body part.

8. A member according to any one of Claims 2 to 7 wherein said fastening means comprises a weld or means mechanically interfitting with at least one edge portion.

9. A member according to Claim 8 wherein fastening means comprise clip means interfitting with both edge portions, or a formation or formations on one edge portion interfitting with the other edge portion.

10. A member according to Claim 9 wherein a pressing or like operation or operations is performed to deform the interfitting parts into a close-fitting relationship.

11. A member according to any one of the preceding Claims wherein at least one attachment portion comprises portions of the member displaced out of their original cross-sectional positions into positions adjacent to one another and adapted to cooperate with fastening means.

12. A member according to Claim 11 wherein the body part is a compound member comprising two or more components secured together and, to provide the attachment portion at an end of the structural member, portions of each of said components are displaced out of their original cross-sectional positions, into positions wherein they will lie adjacent to one another, in the member, prior to connection of the components to one another to form the member.

13. A member according to any one of Claims 1 to 10 wherein at least one attachment portion comprises an attachment component formed separately from said body part and fastened thereto.

14. A member according to Claim 13 wherein the attachment component is of channel shape, the limbs of the channel being disposed in side-by-side relationship with two opposed walls of the body part.

15. A member according to Claim 13 wherein the attachment component is fastened to said body part by fasteners.

16. A member according to Claim 15 wherein reinforcing means are provided to reinforce the walls of the body part.

17. A method of providing an elongate structural member comprising an elongate body part having an attachment portion at each end, comprising the step of cold forming sheet metal into the cross-sectional shape required for the body part and securing wall portions of the body part to one another along edge portions of the wall portions extending length wise of the member and lying adjacent to one another, by fastening means.

18. A method according to Claim 17 comprising displacing attachment portions of the member out of their original cross-sectional positions into positions adjacent to one another and providing means for cooperation of said portions with fastening means.

19. A method according to Claim 17 comprising fastening an attachment component, formed separately from said body part, to said body part.

20. A building structure comprising two spaced apart elements having a structural member according to any one of Claims 1 to 16 or made according to any one of Claims 17 to 19 extending therebetween and connected thereto in bracing relationship.

21. Any novel feature or novel combination of features disclosed herein and/or illustrated in the accompanying drawings.

FIG 1A

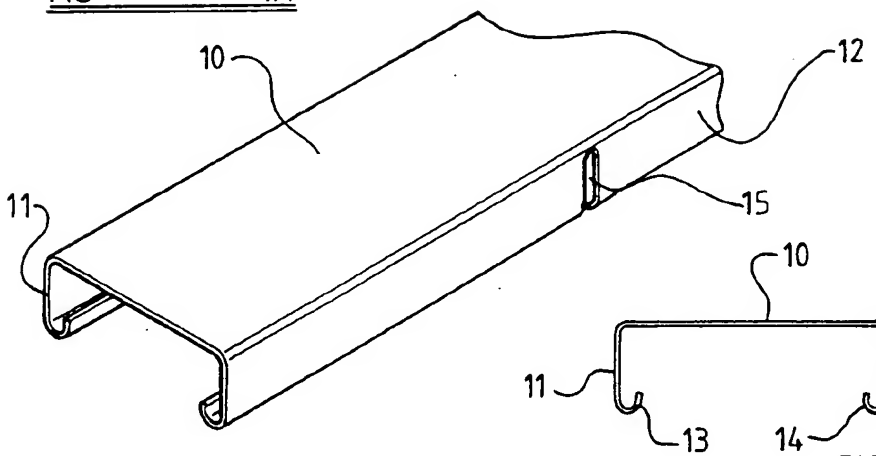
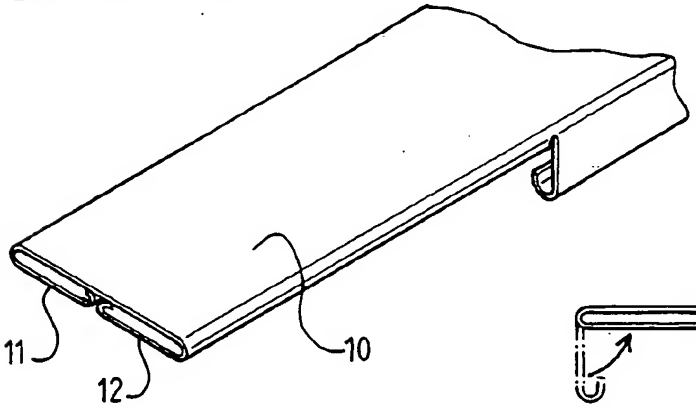


FIG 1B

FIG 2A



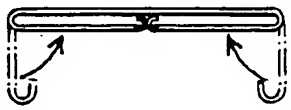


FIG 2B

FIG 3A

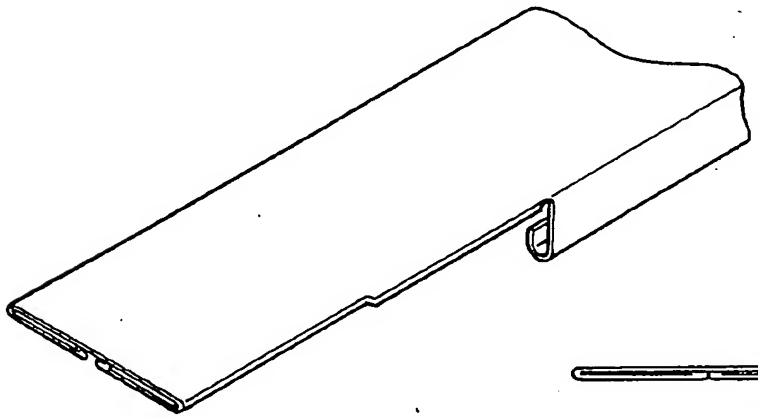


FIG 3B

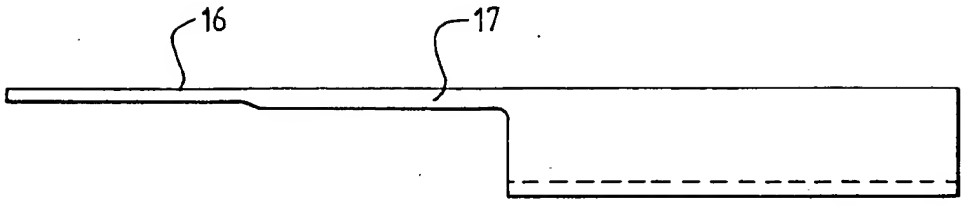


FIG 4

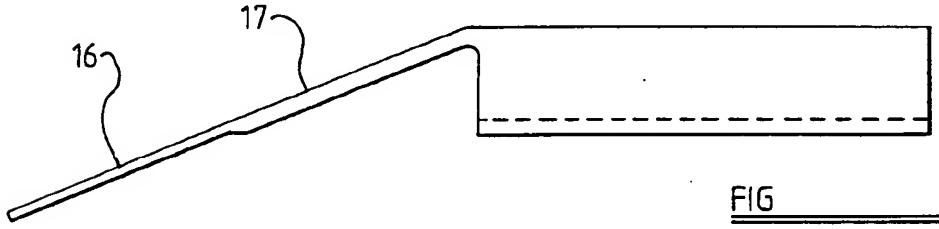


FIG 5

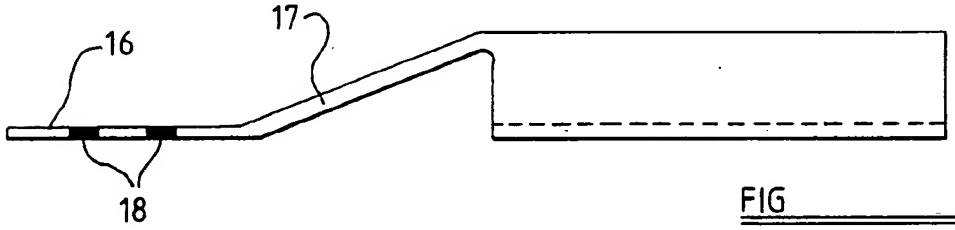


FIG 6

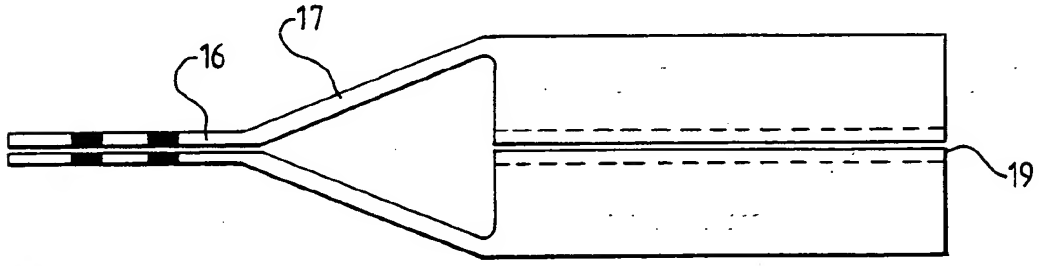


FIG 7

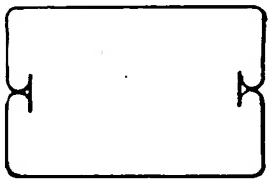
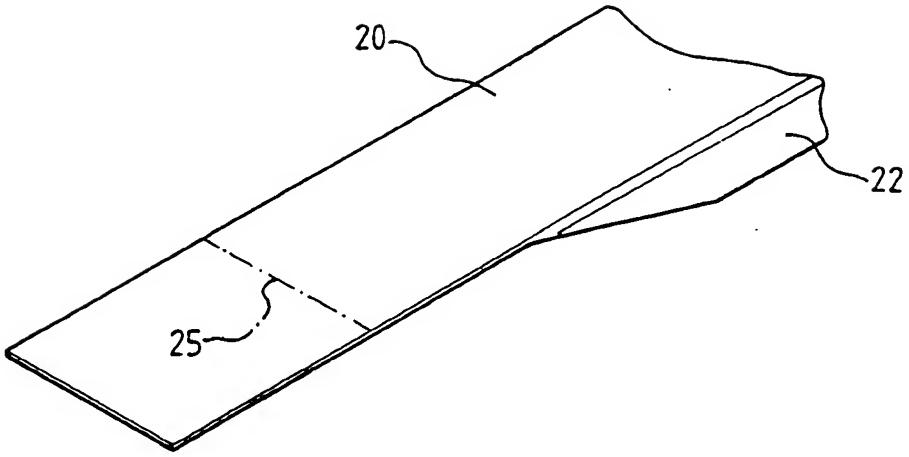


FIG 7a

FIG 8A



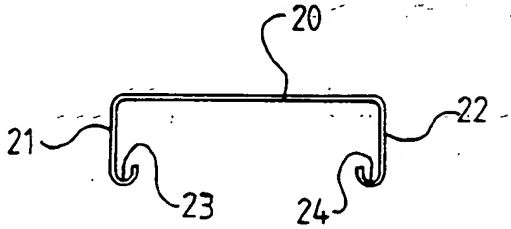


FIG 8B

FIG 9A

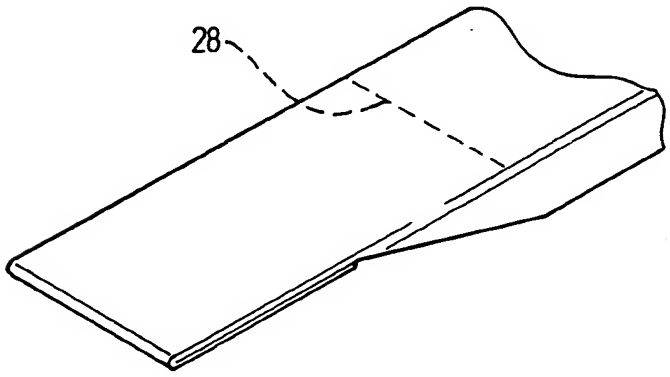


FIG 9B

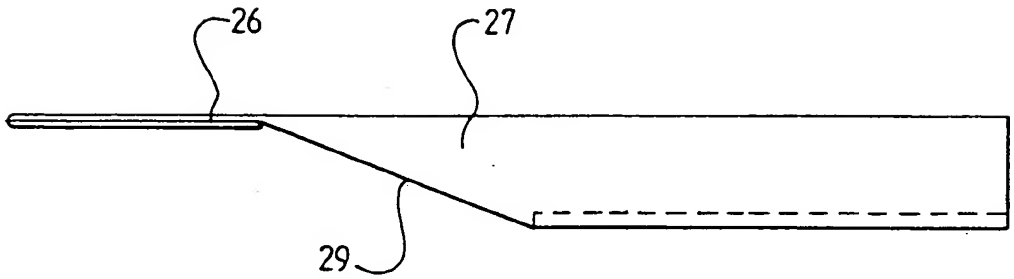


FIG 10

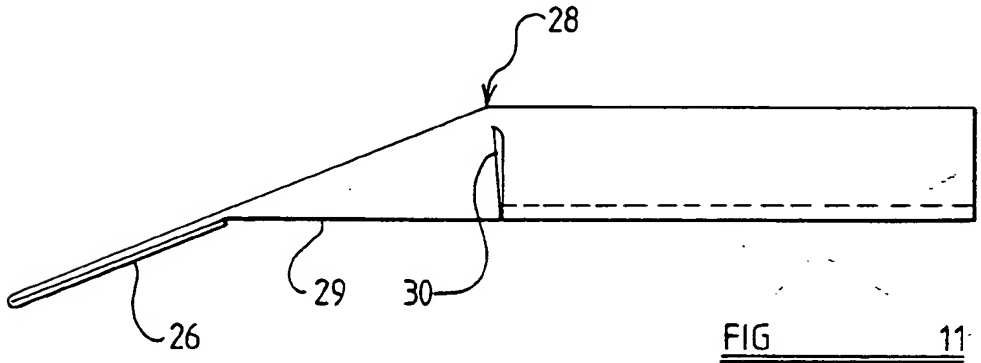


FIG 11

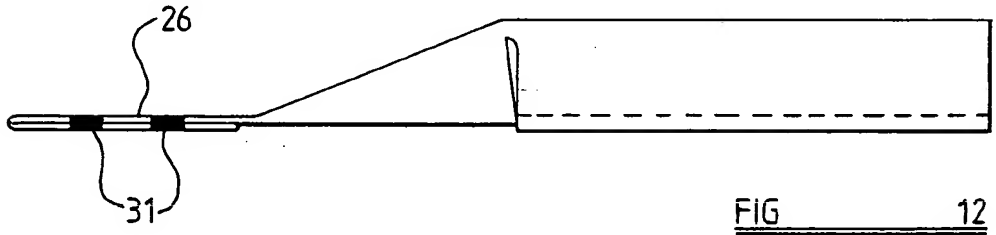


FIG 12

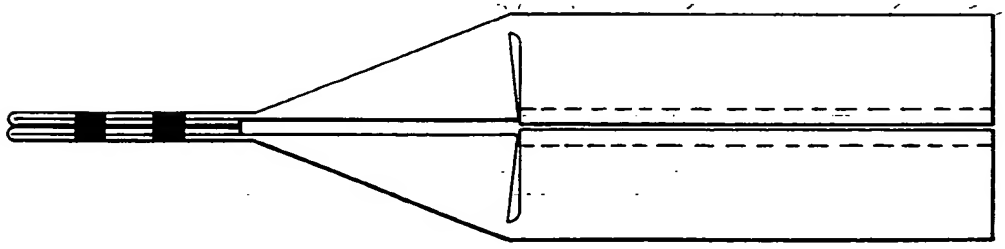


FIG 13

FIG 14

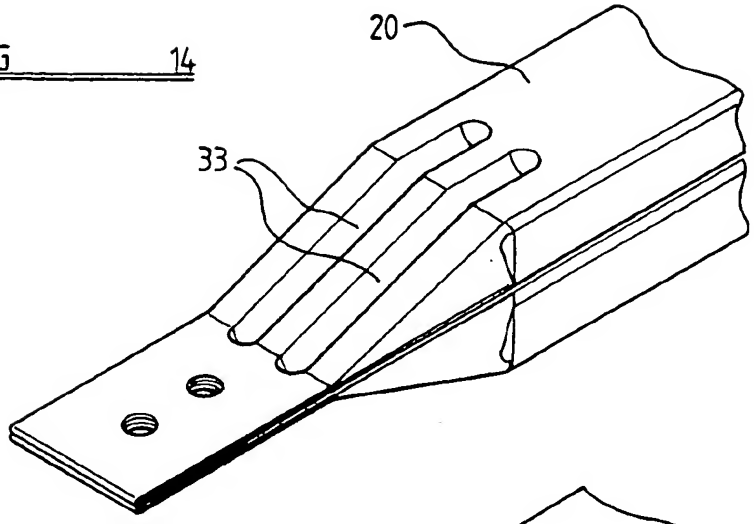


FIG 15

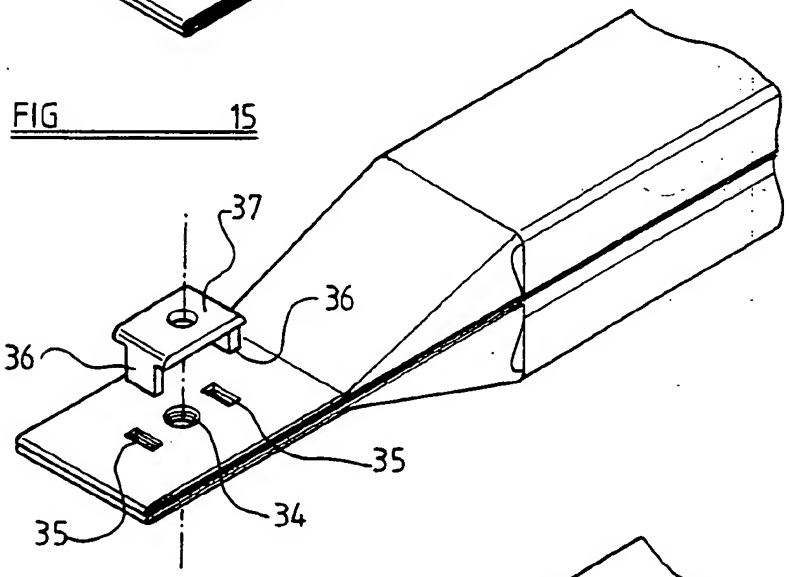
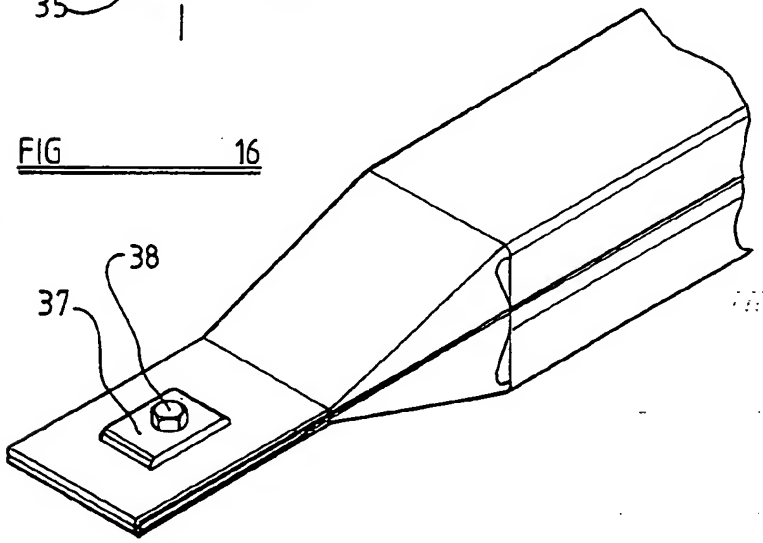


FIG 16



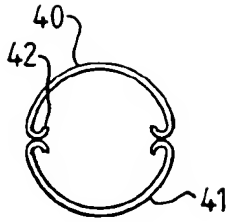


FIG 17

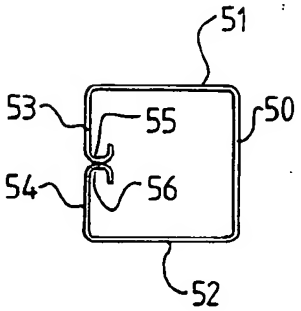


FIG 18

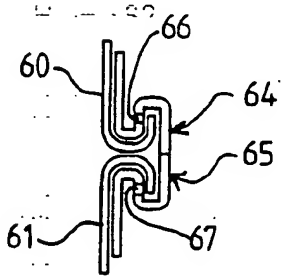


FIG 19

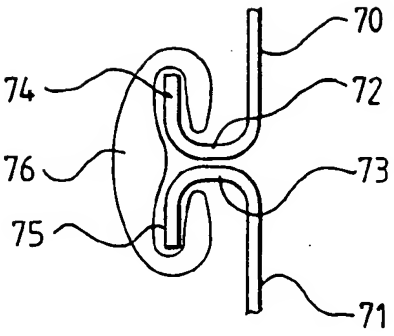


FIG 20A

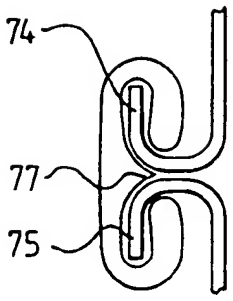
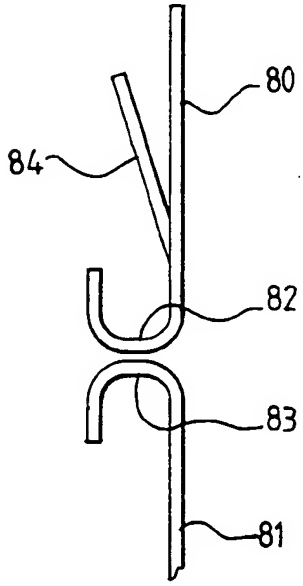


FIG 20B

FIG 21



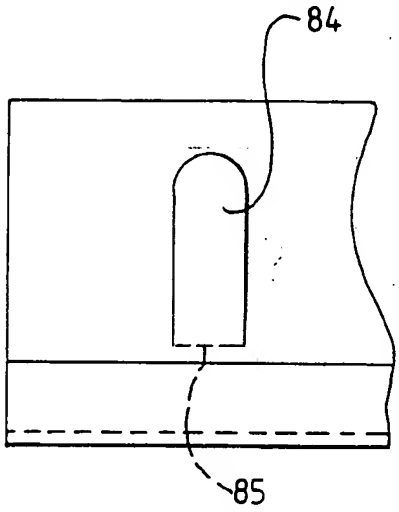


FIG 22

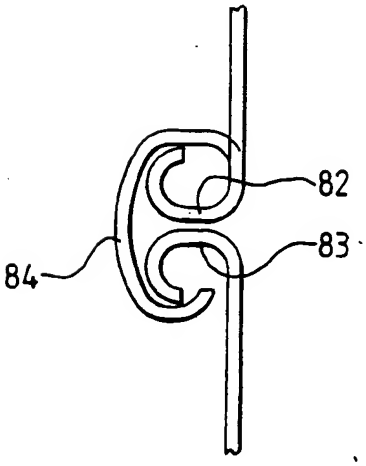


FIG 23B

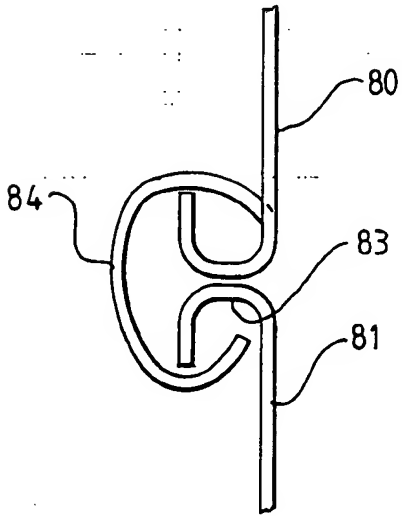


FIG 23A

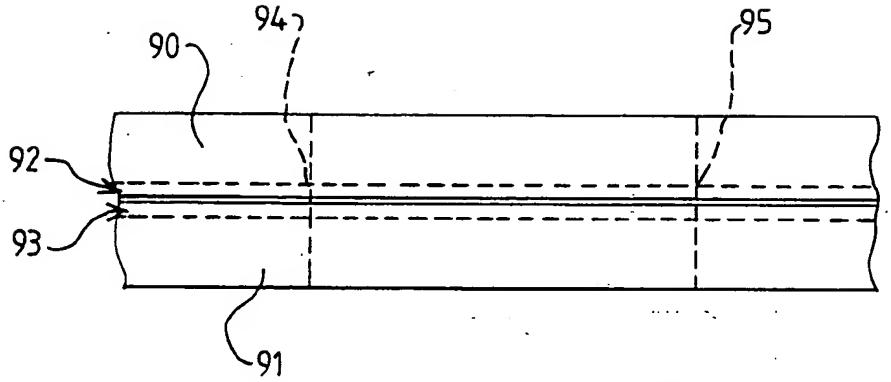


FIG 24

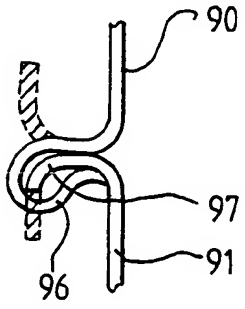


FIG 25A

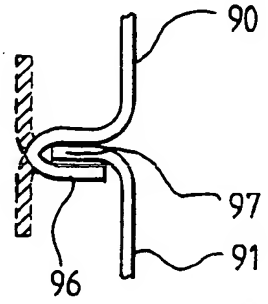


FIG 25B

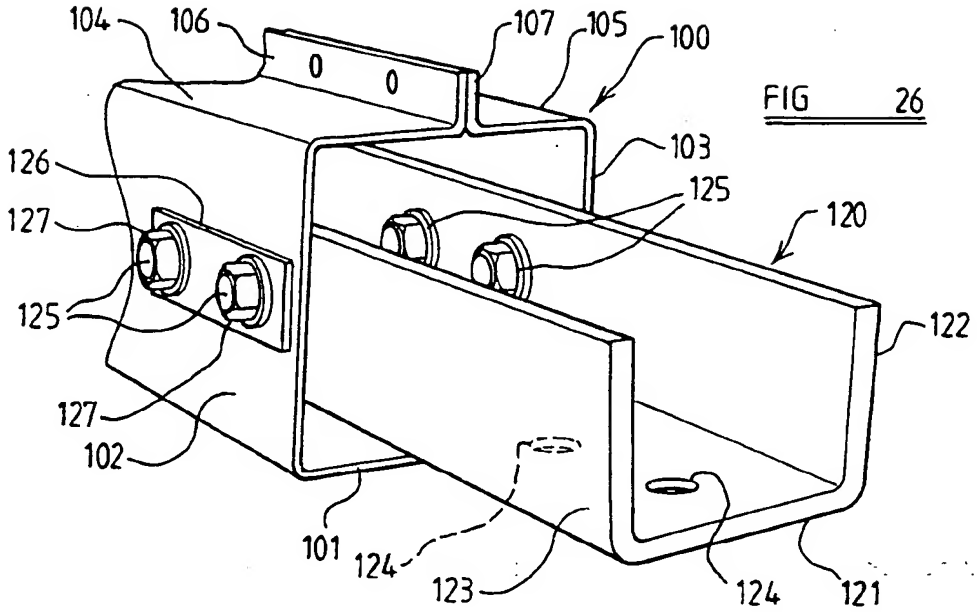


FIG 26

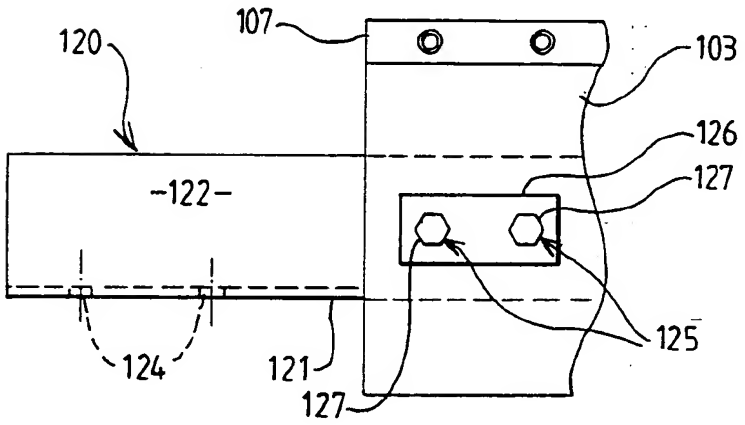


FIG 27

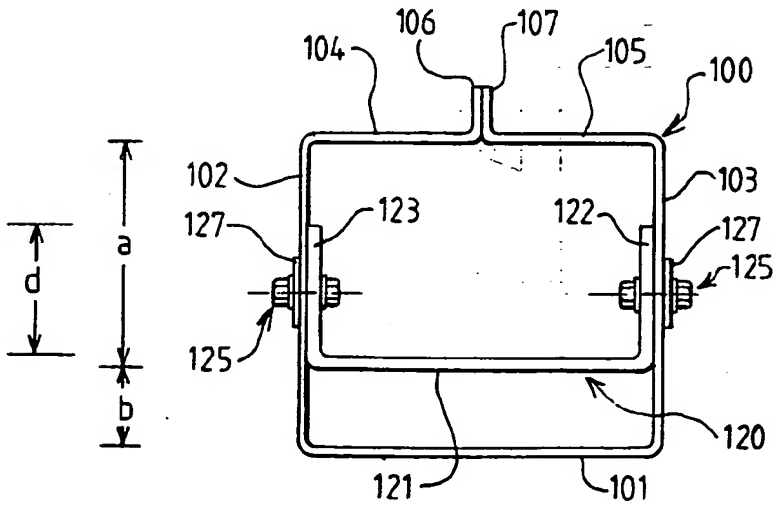
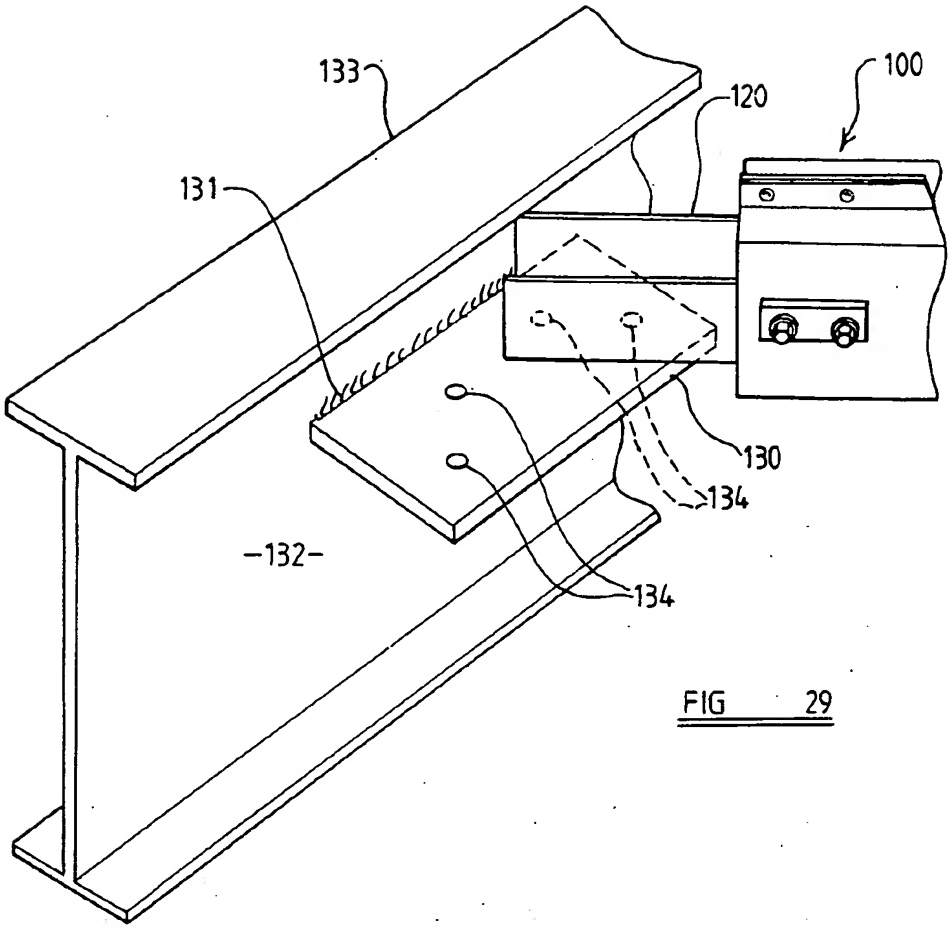


FIG 28


133
120
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132
134

FIG 29

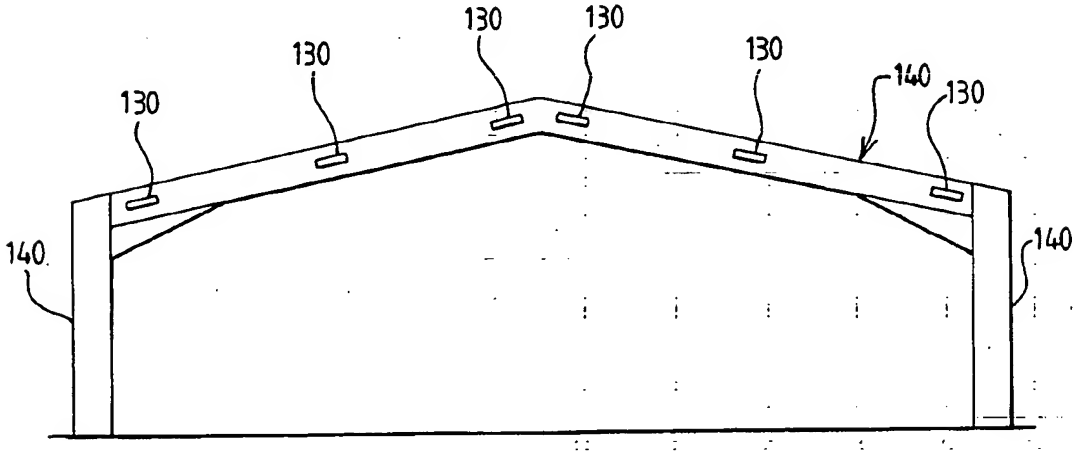
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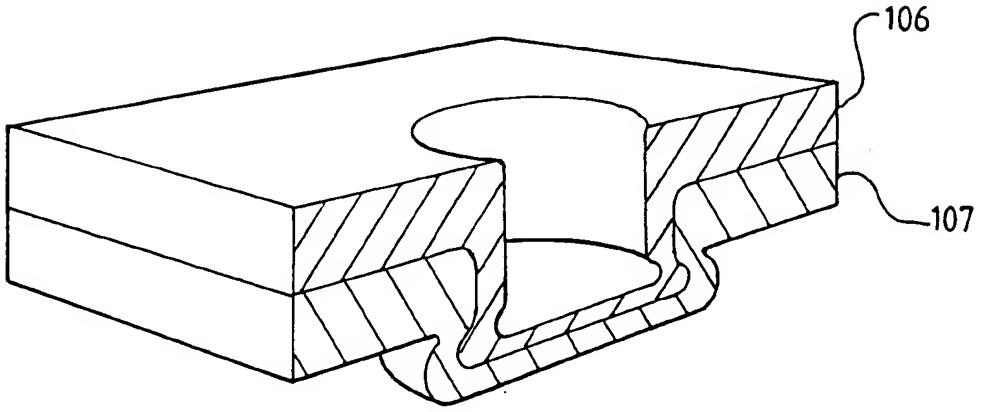
FIG 30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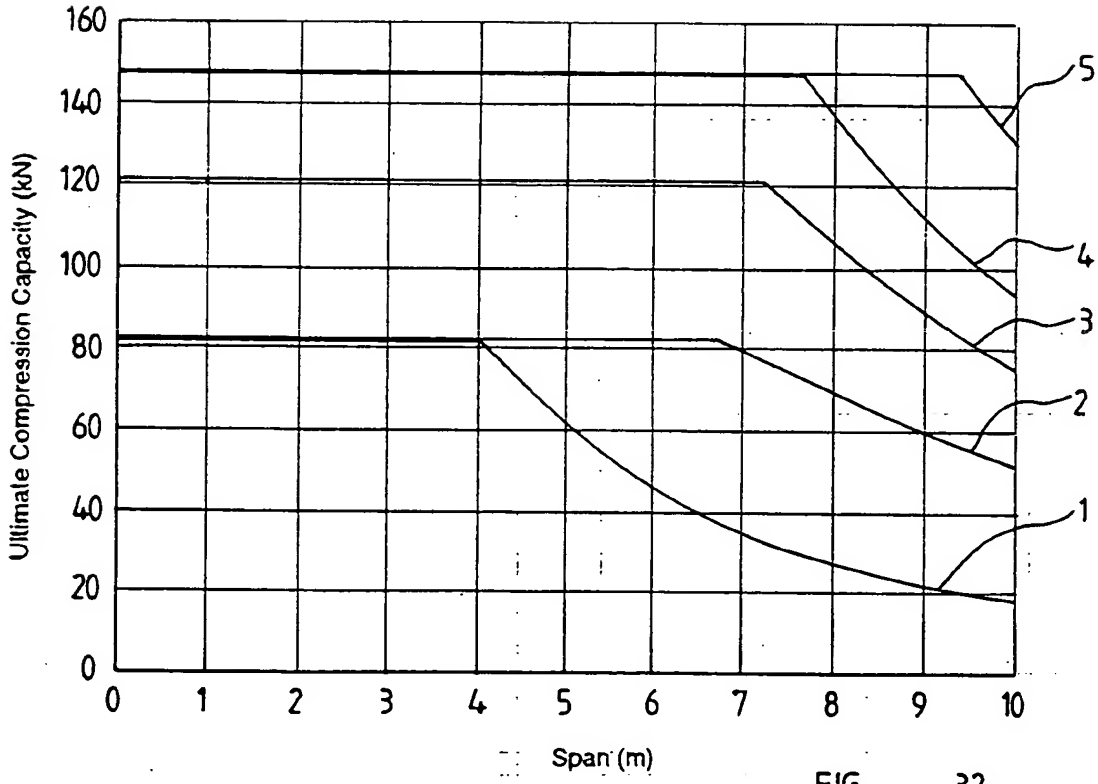
107

FIG 31


160
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80
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40
20
0
Ultimate Compression Capacity (kN)
0
1
2
3
4
5
6
7
8
9
10
Span (m)
5
4
3
2
1

FIG 32

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 5891

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	GB-A-1 476 323 (WARD BROTHERS) 10 June 1977 * page 2, line 11-65; figures *	1-3,7-9, 13, 15-17, 19-21	E04C3/07 E04C3/40
X Y	FR-A-2 265 938 (SCANOVATOR AB) 24 October 1975 * page 3, column 4 - page 4, column 18 * * page 6, line 1-8; figures *	1-4, 8-10, 13-16, 20,21 5,6	
Y A	FR-A-1 298 059 (MALKMUS-DÖRNEMANN) 6 July 1962 * figure 1 *	5,6 1	
X A	GB-A-1 562 688 (WARD BROTHERS) 12 March 1980 * page 1, line 9-19; figures *	1,13,20, 21 17,19	TECHNICAL FIELDS SEARCHED (Int.Cl.6) E04C
X A	FR-A-1 078 020 (ONTWIKKELINGMAAT. "POLYNORM") 15 November 1954 * the whole document *	1-3,7,8, 11,20,21 5,6,12, 16,18	
X	FR-A-1 056 719 (ONTWIK. POLYNORM) 2 March 1954 * column 1 - column 2, paragraph 1; figures *	1,11,20, 21	

-/--

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 December 1994	Righetti, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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A : technological background
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 94 30 5891

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
X	US-A-4 616 453 (SHEPPARD, JR. ET AL.) 14 October 1986 * column 3, line 32 - column 4, line 54; figures 2-5,16-18 *	1,11,20, 21	
A	FR-A-666 100 (H. JUNKERS) 26 September 1929 * page 1, column 2, line 50 - page 2, column 1, line 4; figures *	1,11,20, 21	
A	US-A-4 051 640 (VINCENS) 4 October 1977 * column 9, line 28-66; figure 23 *	1,14	
A	GB-A-1 319 623 (BRITISH ALUMINIUM) 6 June 1973 * page 1, line 87-94; figures *	1	
A	DE-A-19 49 179 (SIDERURGICA OCCID.) 30 July 1970 * page 2, paragraph 2; figures *	1,4,17, 20,21	
A	US-A-2 457 148 (W. J. HALL ET AL.) 28 December 1948 * figures *	9	TECHNICAL FIELDS SEARCHED (Int.Cl.6)

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	14 December 1994	Righetti, R

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
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P : intermediate document

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E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)